Improving Satellite Microwave Products

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- Distributed Information Services for Climate and Ocean Products and Visualizations for Earth Research

- We provide multi-sensor, multi-platform highly accurate, long-term satellite microwave data products suitable for Earth research applications via easy-to-use display and data access tools.

- Collaboration between:
  - Remote Sensing Systems
  - ITSC at the University of Alabama in Huntsv
  - NASA / Global Hydrology & Climate Center

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NASA

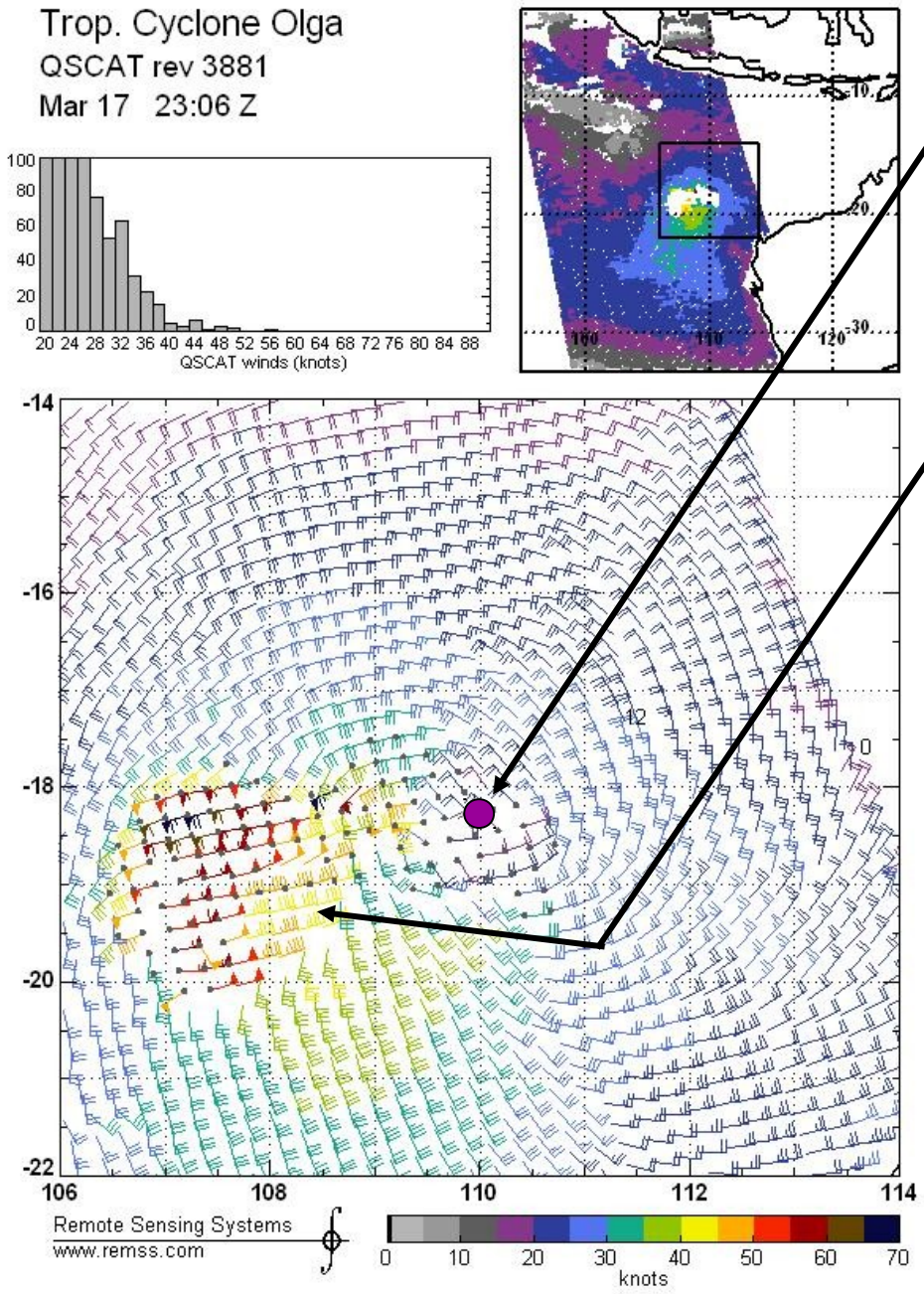
Tropical Cyclone Related Work at RSS

1) Fixing rain effects on scatterometer data

2) Progress in obtaining radiometer wind retrievals in rain

3) TC intensity studies using Microwave SSTs

4) TC archive interface useful for retrospective studies

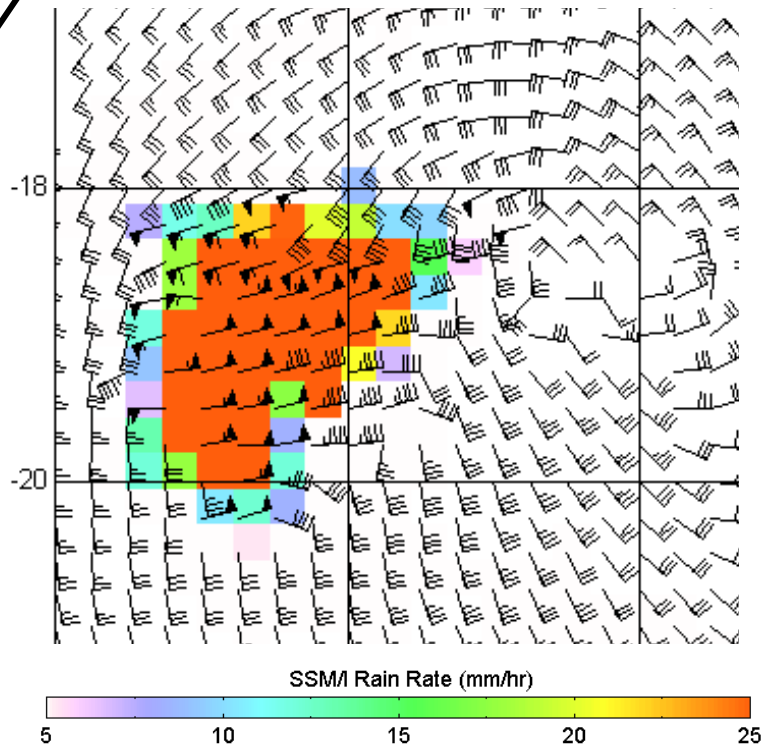


Reported storm location at
0 Z Mar 18 2000

Rain effects:

Cross swath vectors

Higher wind speeds



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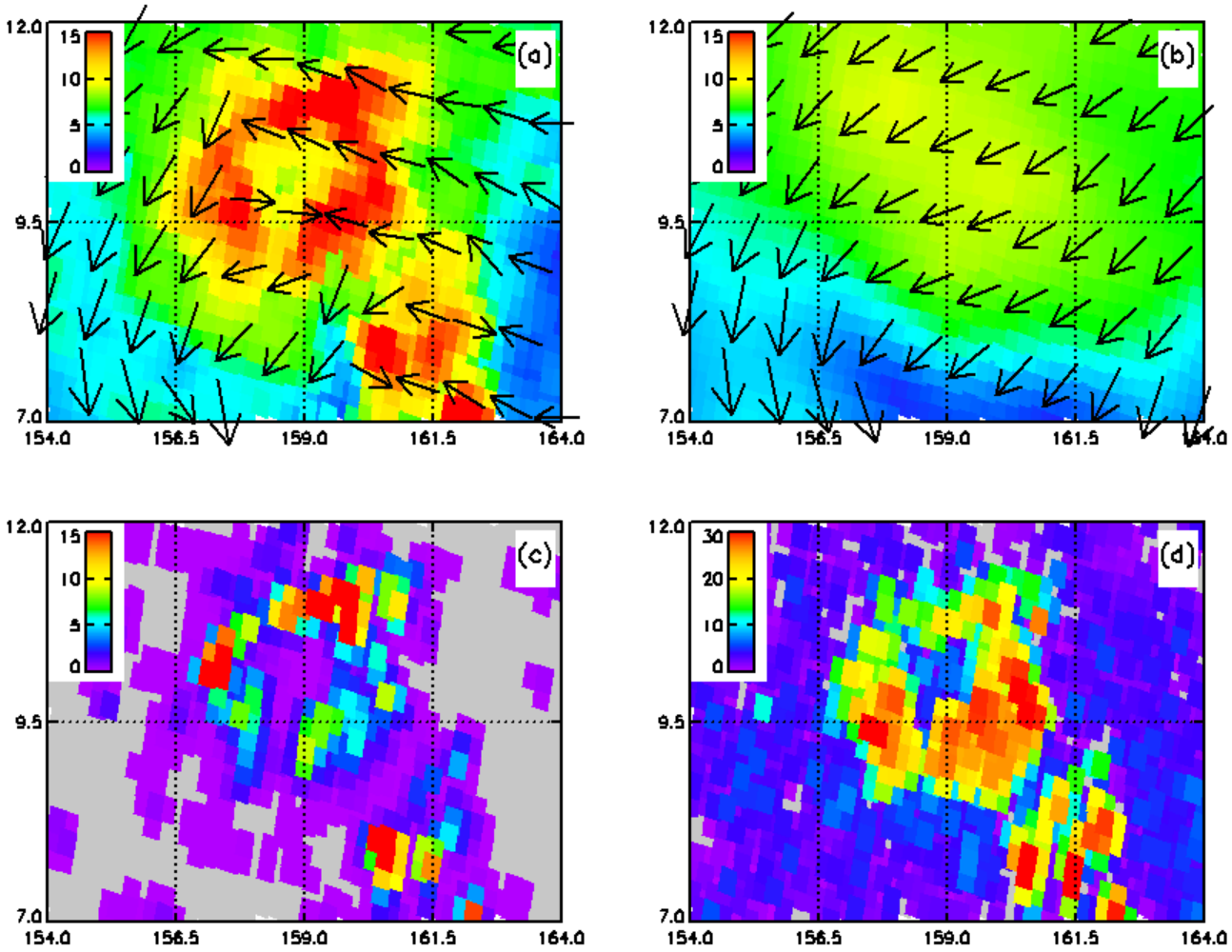
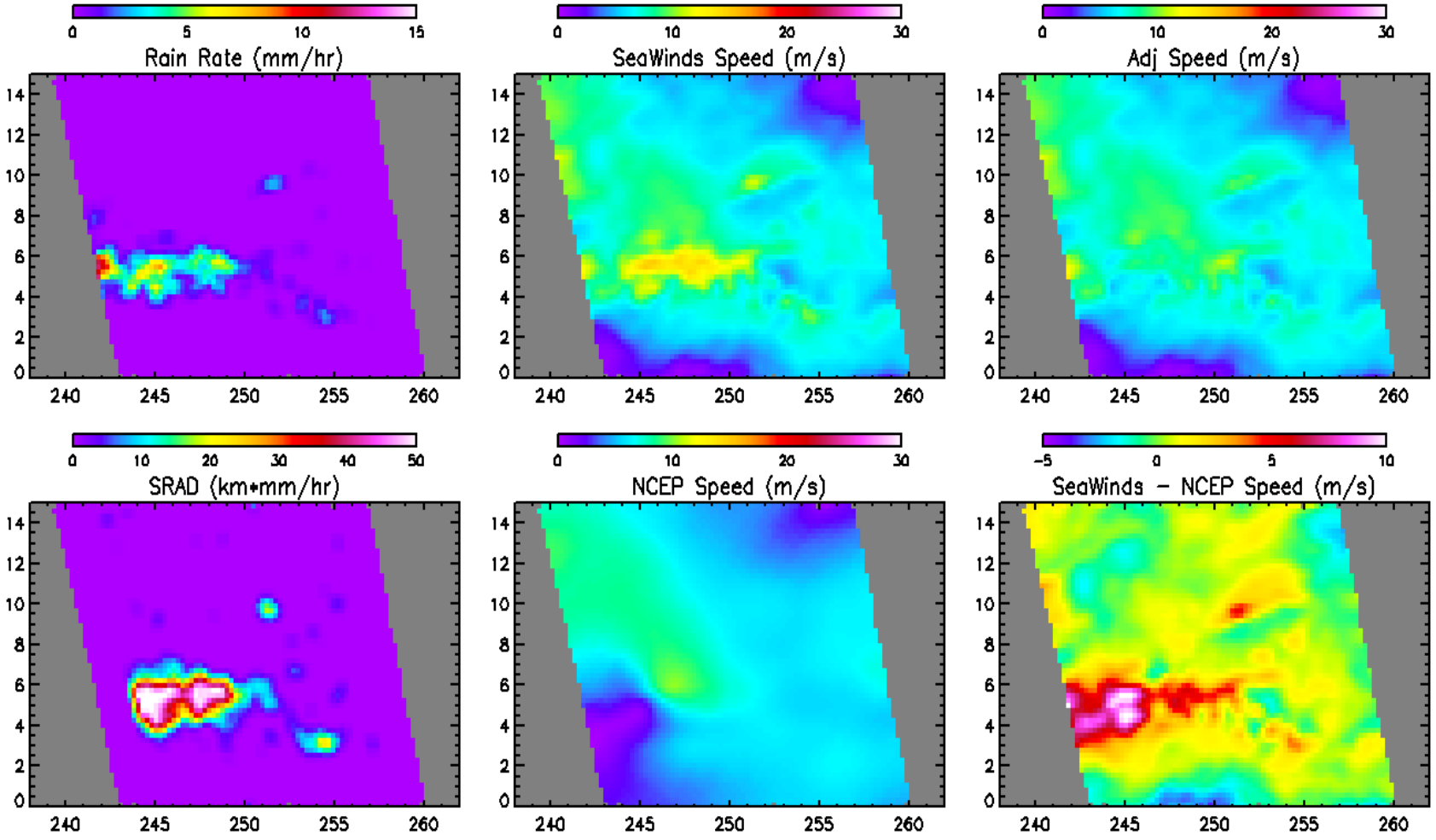
We Need More Than Just Rain Rate



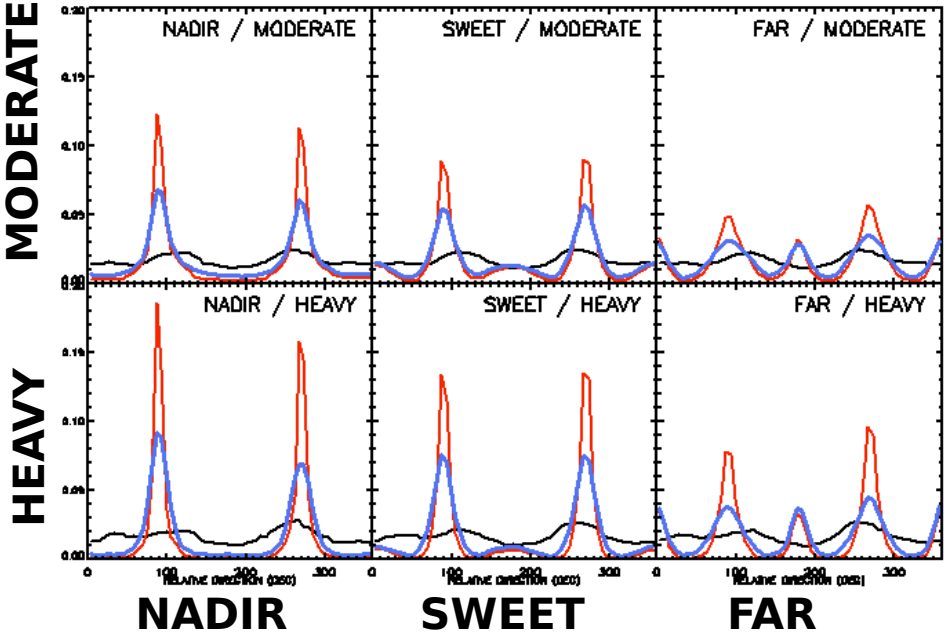
28 June 03, West of the Marshall Islands, Rev 2806



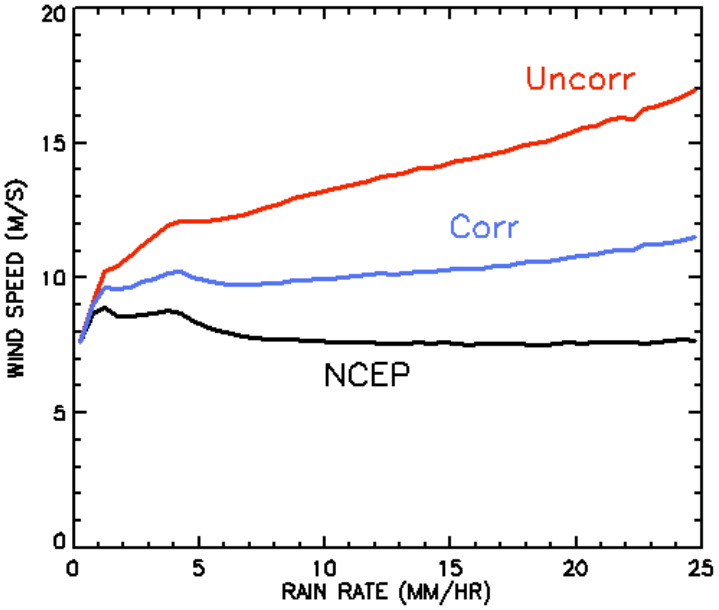
Tropical convective rain off the western Central American coast on 10 April 2003
The uncorrected winds are TOP-CENTER and the corrected winds are TOP-RIGHT

Cross-Track Directions Reduced

NCEP, UNCORRECTED, CORRECTED



Average Wind Speed Improved

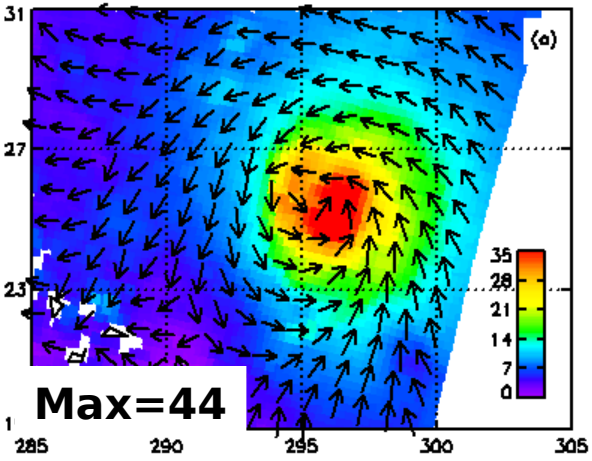


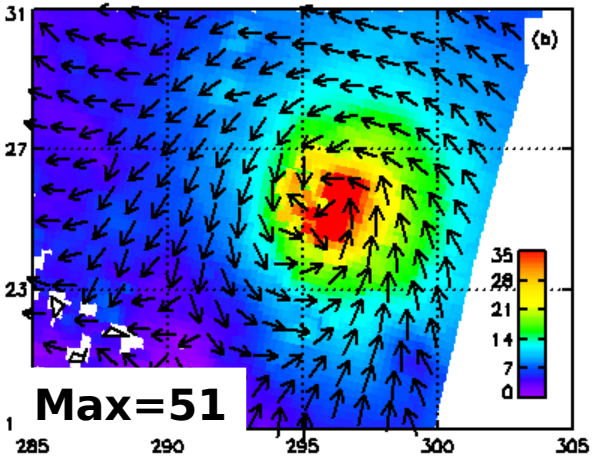
"Correcting Active Scatterometer Data for the Effects of Rain Using Passive Radiometer Data,"

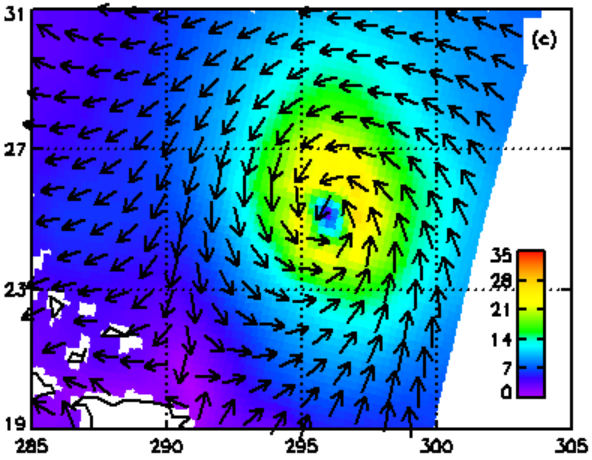
2006, K. A. Hilburn, F. J. Wentz, D. K. Smith, and P. D. Ashcroft, Journal of Applied Meteorology, Vol. 45, No. 3, pages 382398

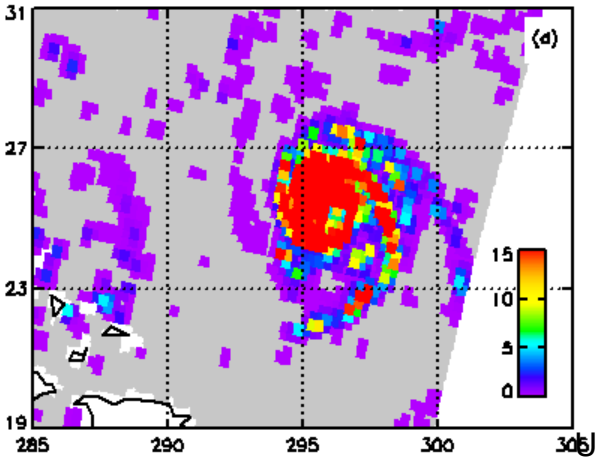
Hurricane Fabian

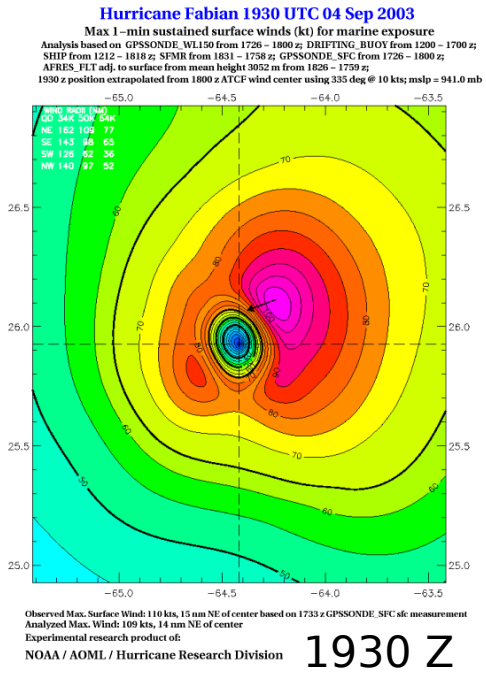
1500 Z











1930 Z

No scat in H*Wind

Max = 110 kts = 57 m/s

US NAVY: = **50 m/s**

0.88 x 1-min mean = 10-min mean

04 Sep 03, Rev 3770

Tropical Cyclone Related Work at RSS

1) Fixing rain effects on scatterometer data

2) Progress in radiometer wind retrievals in rain

3) TC intensity studies using Microwave SSTs

4) TC archive interface useful for retrospective studies

Problems to Retrieve Passive MW Winds Under Rain

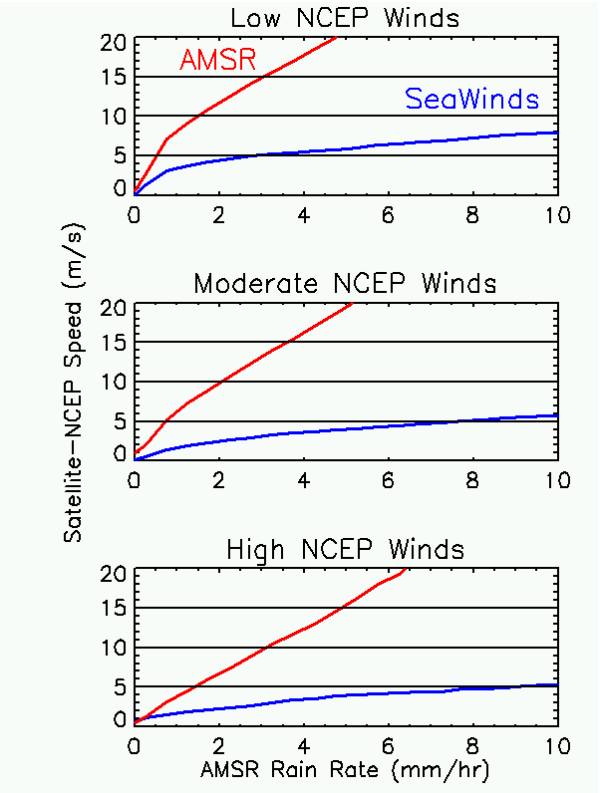
Possible Mitigations

- Attenuation
  - Signal/Noise decreases. Especially at higher frequencies.
  - ➢ Use C- Band + X- Band
  - ➢ Lower resolution

- Rain signal very similar to wind signal
  - Algorithm treats increase in rain the same way as increase in wind.
  - ➢ Train algorithm under rain
  - ➢ Try to find channel combinations that are less or n sensitive to rain but sensitive to wind.

- Wind speed retrieval algorithm without rain is based on physical radiative transfer model (RTM

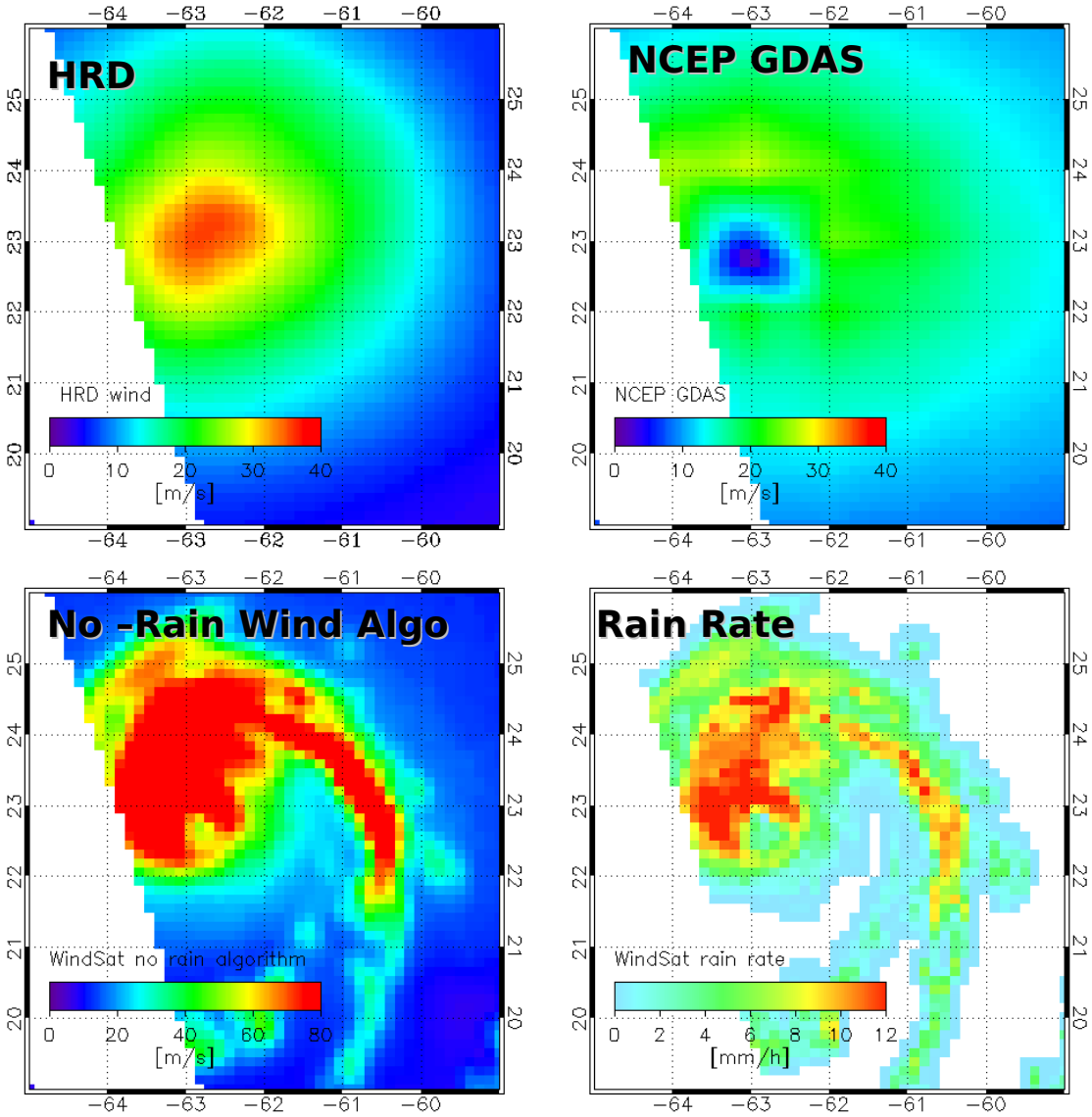
  Rain is difficult to model in RTM
  - Cloud type
  - Beamfilling (rain filling part of retrieval cell)
  - Depression in atmospheric temperature (scattering, ...)
  - ➢ Use statistical algorithm (measured TBs) rather than physical algorithm (modeled TBs)



Study Data Sets

- Wind vectors from Surface Wind Analysis from the NOAA's Hurricane Research Division (HRD)
- Collocated with WindSat brightness temperatures
  - NRL Level0 data processed by RSS into Level2
  - Calibrated
  - Optimum interpolated onto 1/8 deg fixed Earth grid (X-band resolution)
- 17 storms during 2003 and 2004
- Rain flagged (TB exceeds boundary for rain free ocean scenes)
- 3 hour time window
- Scale HRD winds (1 minute sustained) by 0.88 to compare with satellite winds (10 minute sustained)
- Resample HRD winds (5 km) onto WindSat footprint (30 km for X-band)
- Visual shift of HRD field so that storm center coincides with WindSat
- Half of the set is used for training, the other half for testing
- About 24,000 wind vector cells for test set
- Triple matchup: WindSat – QuikScat – HRD
  - within 3 hours
  - 8 storms during 2003 and 2004
  - exclude if HRD analysis uses QuikScat
  - about 16,000 wind vector cells for testing

FABIAN 03 September 2003



Algorithm trained under rain free conditions measures rain rather than wind

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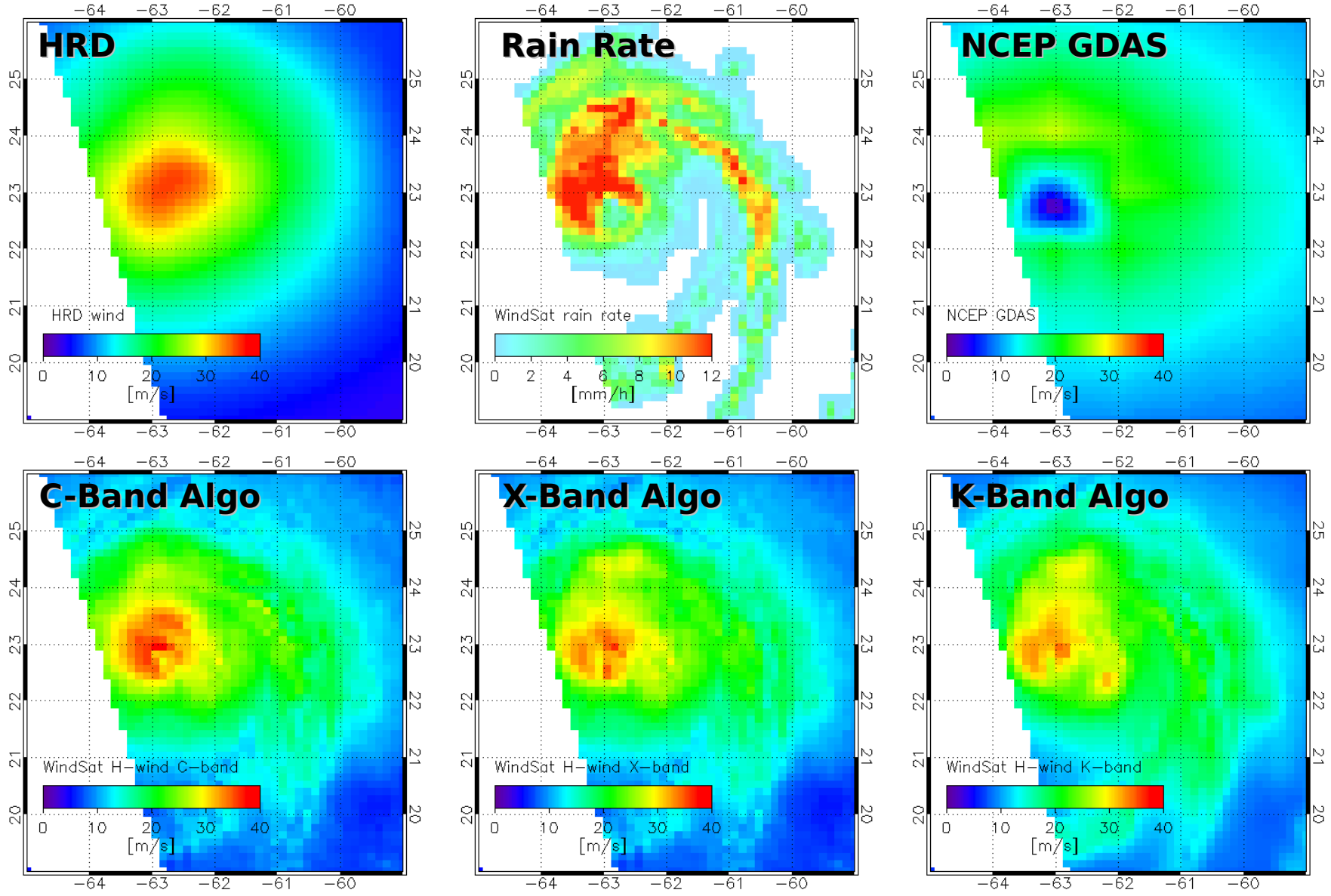

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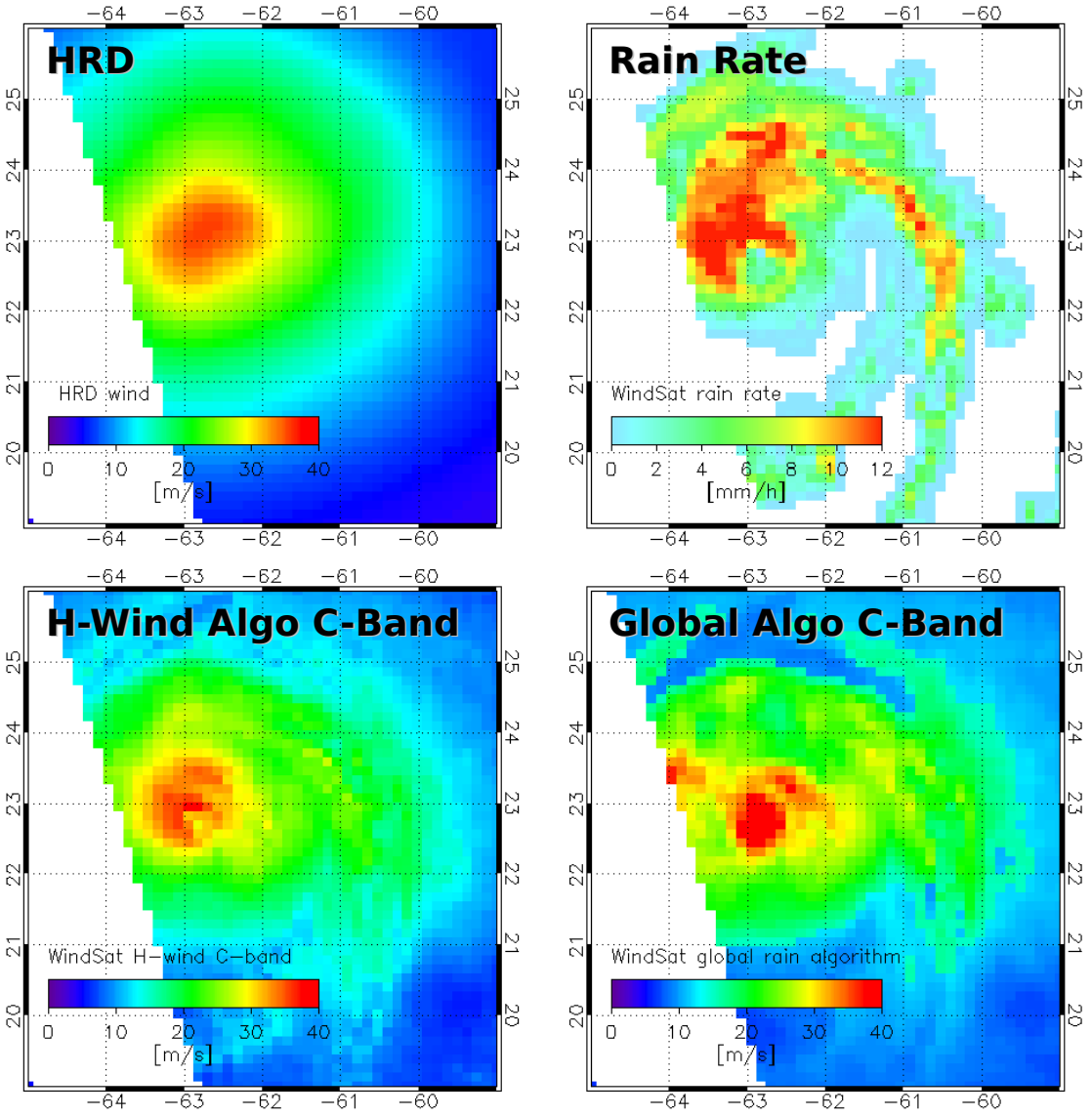
WindSat H-Wind versus Global Algorithm



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Radiometer Wind Vectors in Rain

Capability Chart

	Wind Speed Hurricanes			Wind Speed Global Rain		Wind Direction Hurricanes	
SSM/I	K			no		no	
SSMIS	K			no		no	
TMI	X	K		X		no	
GMI	X	K		X		no	
AMSR-E	C	X	K	C	X	no	
GCOM	C	X	K	C	X	no	
WindSat	C	X	K	C	X	X	wspd >8 m/s rain rate <8 mm/h
MIS	C	X	K	C	X	X	wspd >8 m/s rain rate <8 mm/h 3rd Stokes at X-band

C	X	K	**resolution**

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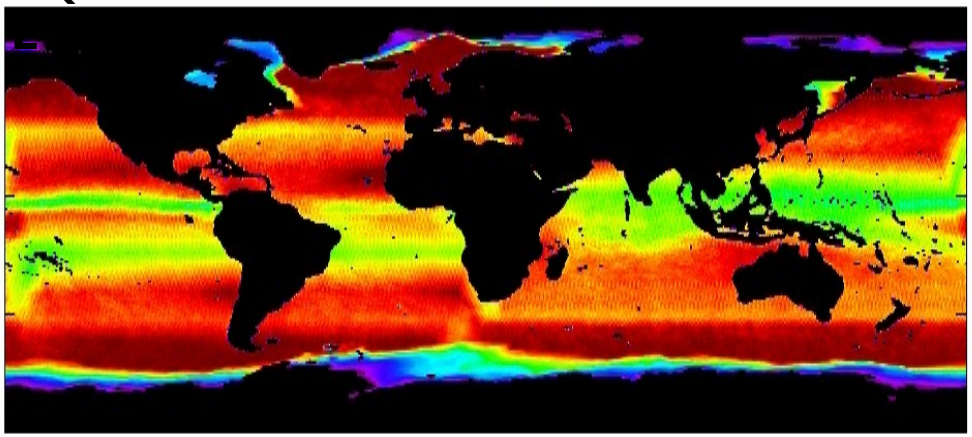
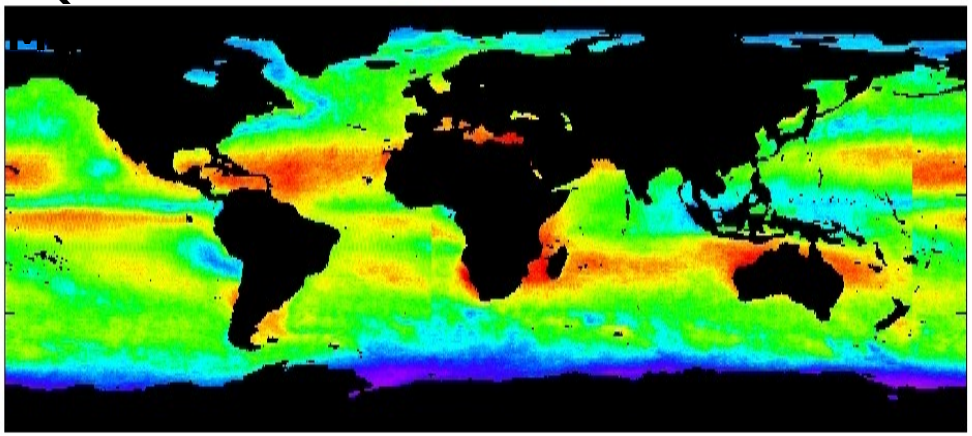
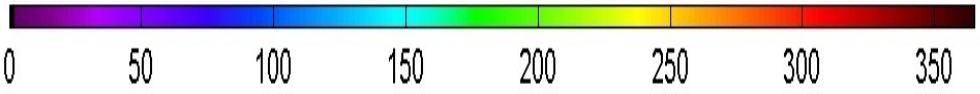
Global SST Observation

AQUA AMSR-



AQUA





Number of days with data

- Daily observation of SST at high latitudes
- Significantly more observations globally
- No “Clear Sky Bias”
- At a spatial resolution useful for NWP and TC forecasting

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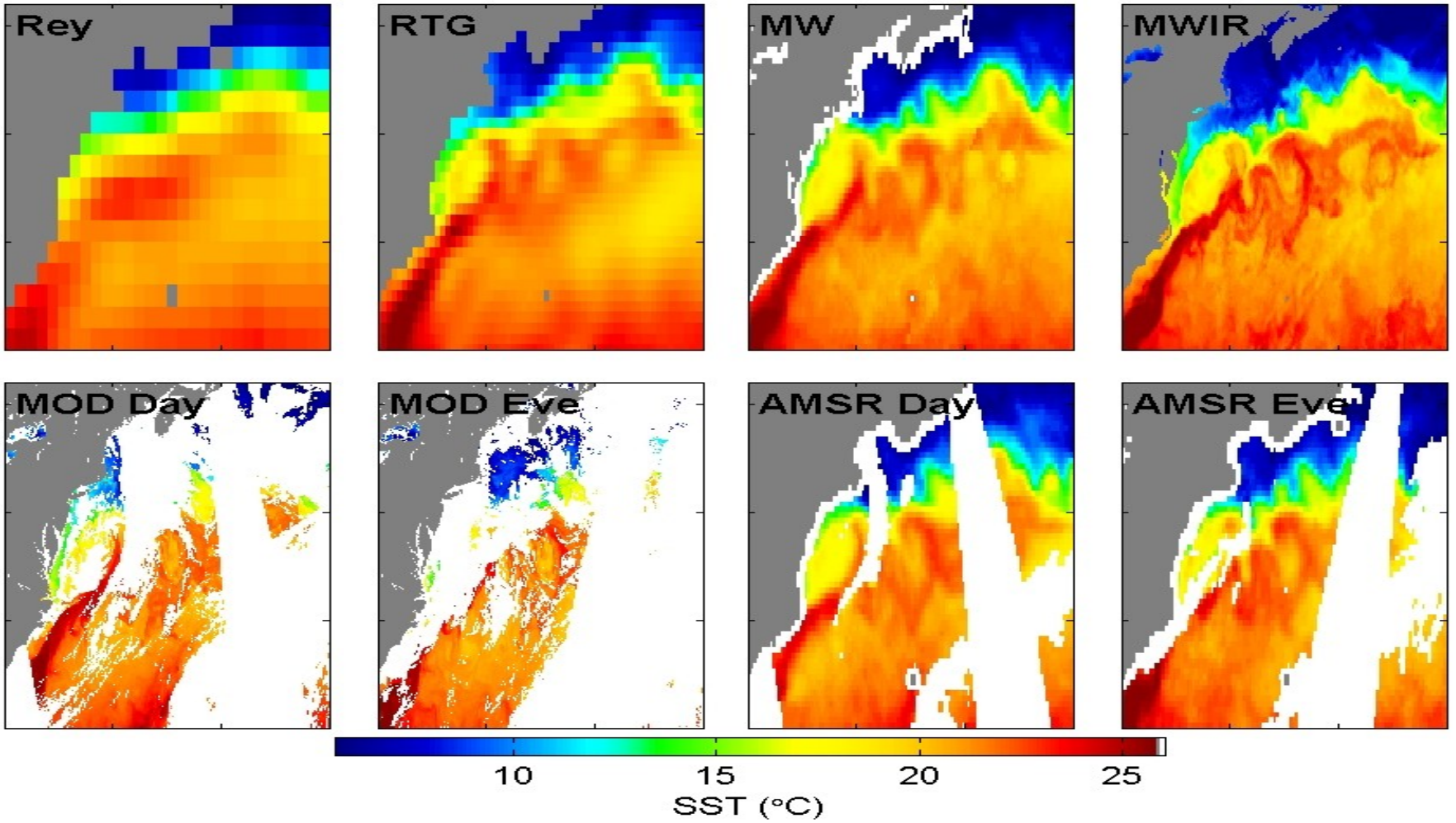
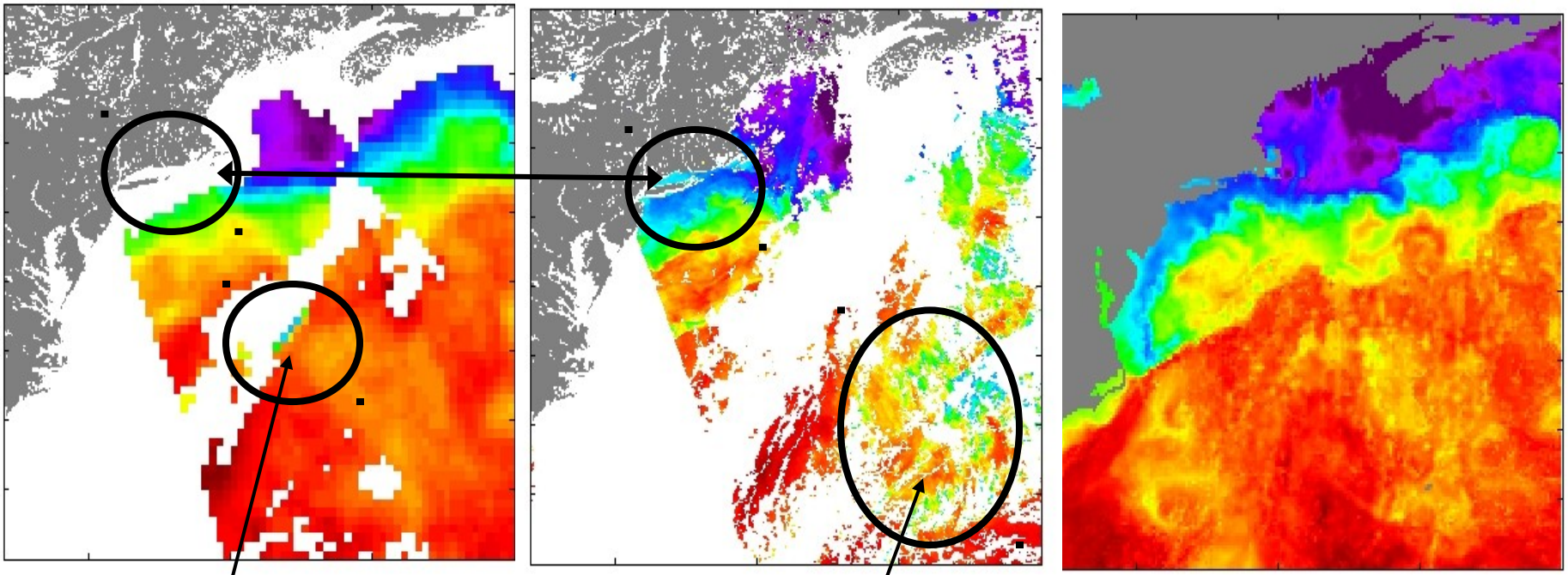


Reynolds	RTG	RSS MW	RSS MW+IR
Weekly	Daily	Daily	Daily
100km	50km	25km	9km
AVHRR	AVHRR	AMSRE, TMI	MODIS, AMSRE & TMI

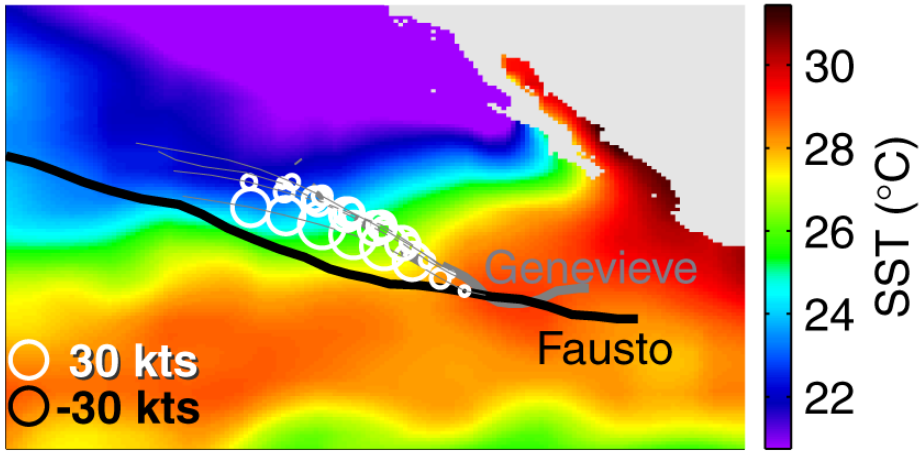
OI SSTs uses strengths of both MW and IR

Version-2, improved and now available

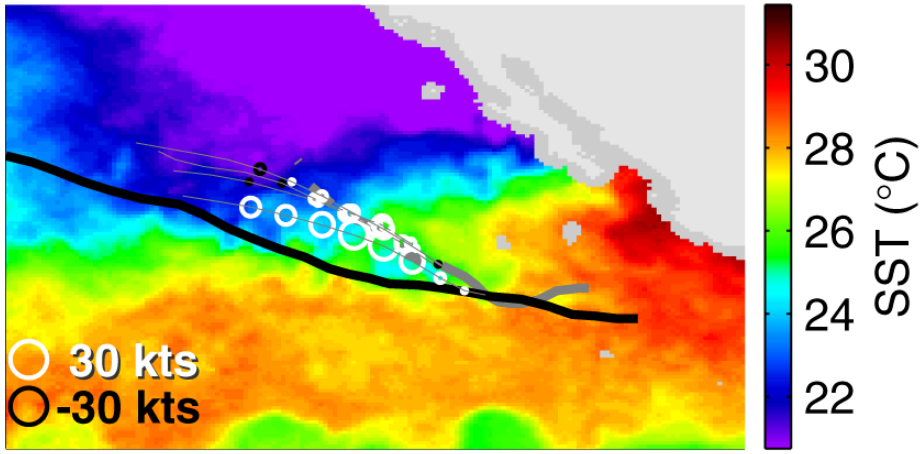


MW SSTs Improve TC Intensity Prediction

SHIPS errors with NCEP OI SST

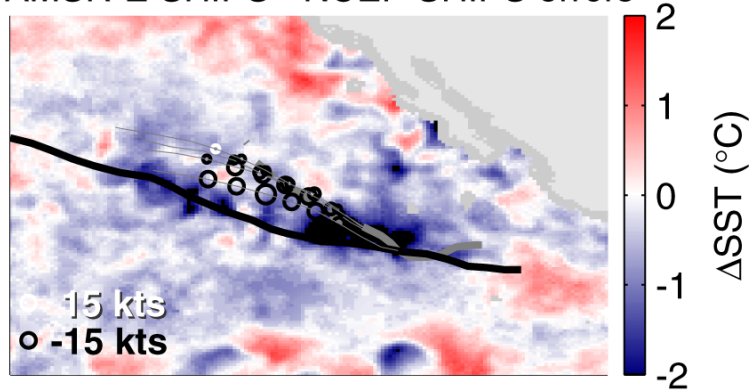


SHIPS errors with AMSR-E OI SST



Intensity forecast errors (especially 3-5 day forecasts) are significantly reduced using AMSR-E OI SSTs due to the improved temporal resolution of cold wakes.

AMSR-E SHIPS - NCEP SHIPS errors



Hurricane Genevieve

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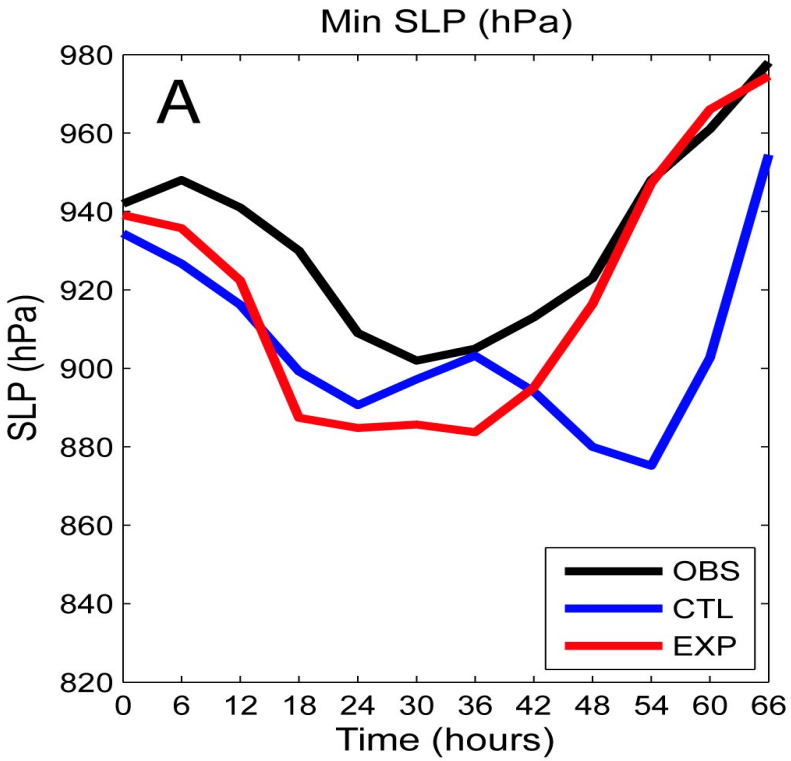
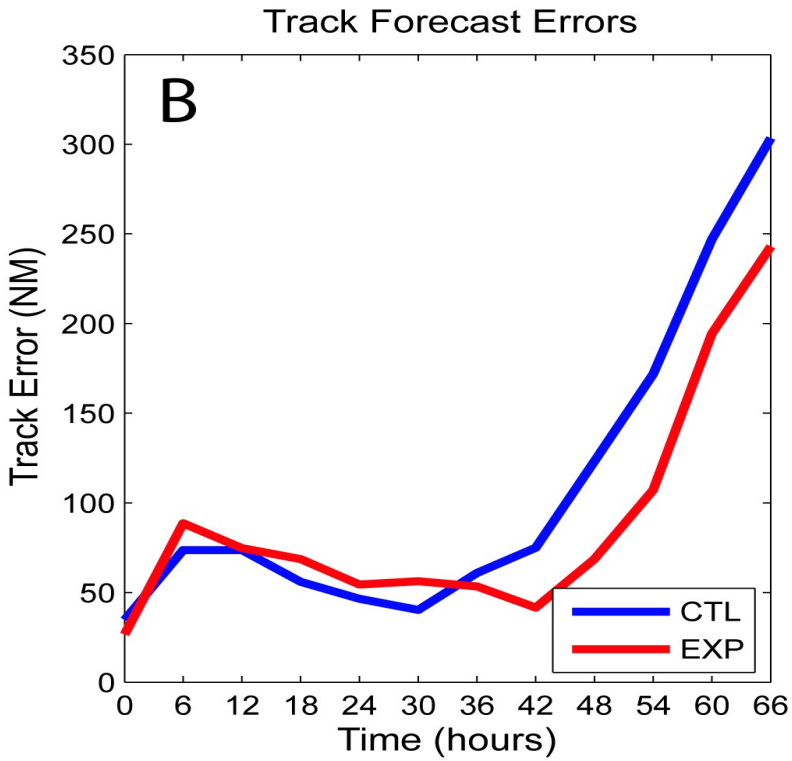
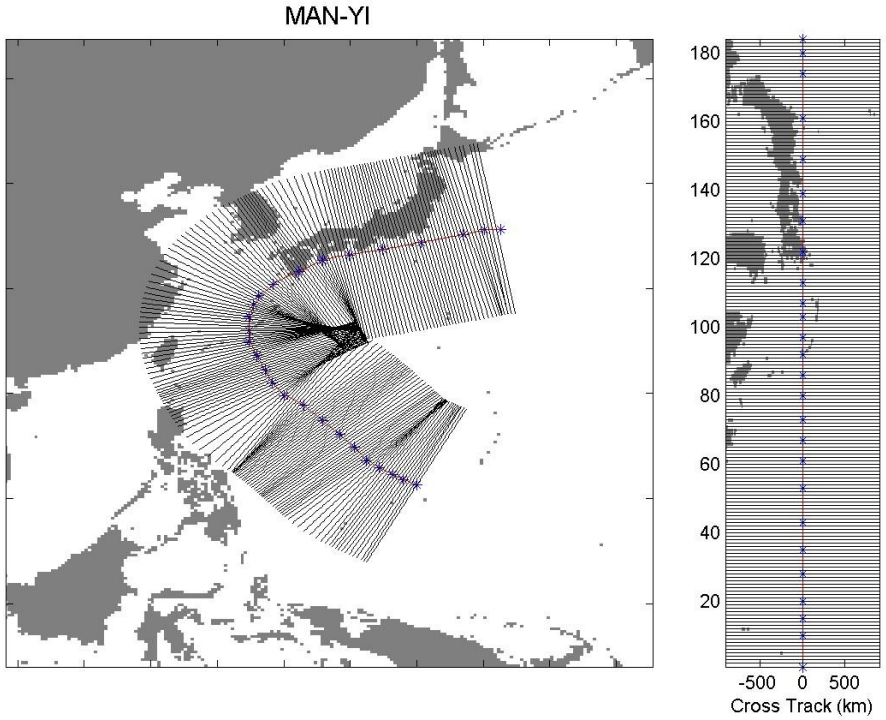
MW SSTs Improve TC Track Prediction

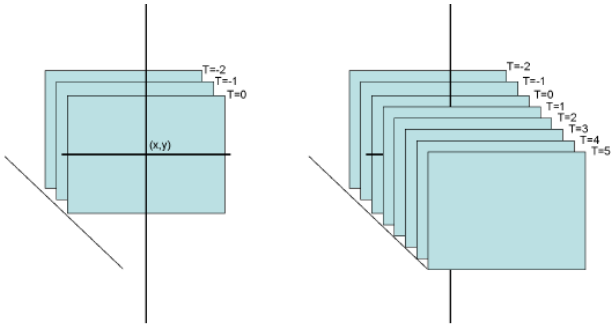
Time series of Hurricane Katrina every 6 hours (12 UCT 27 August to 0600 UTC 30 August 2005, from the best track data (black), the IR-only SST analysis run (blue) and the IR+MW SST run (red). A) The sea level pressure. (SLP) B) The track forecast errors. Image from J. Cummings





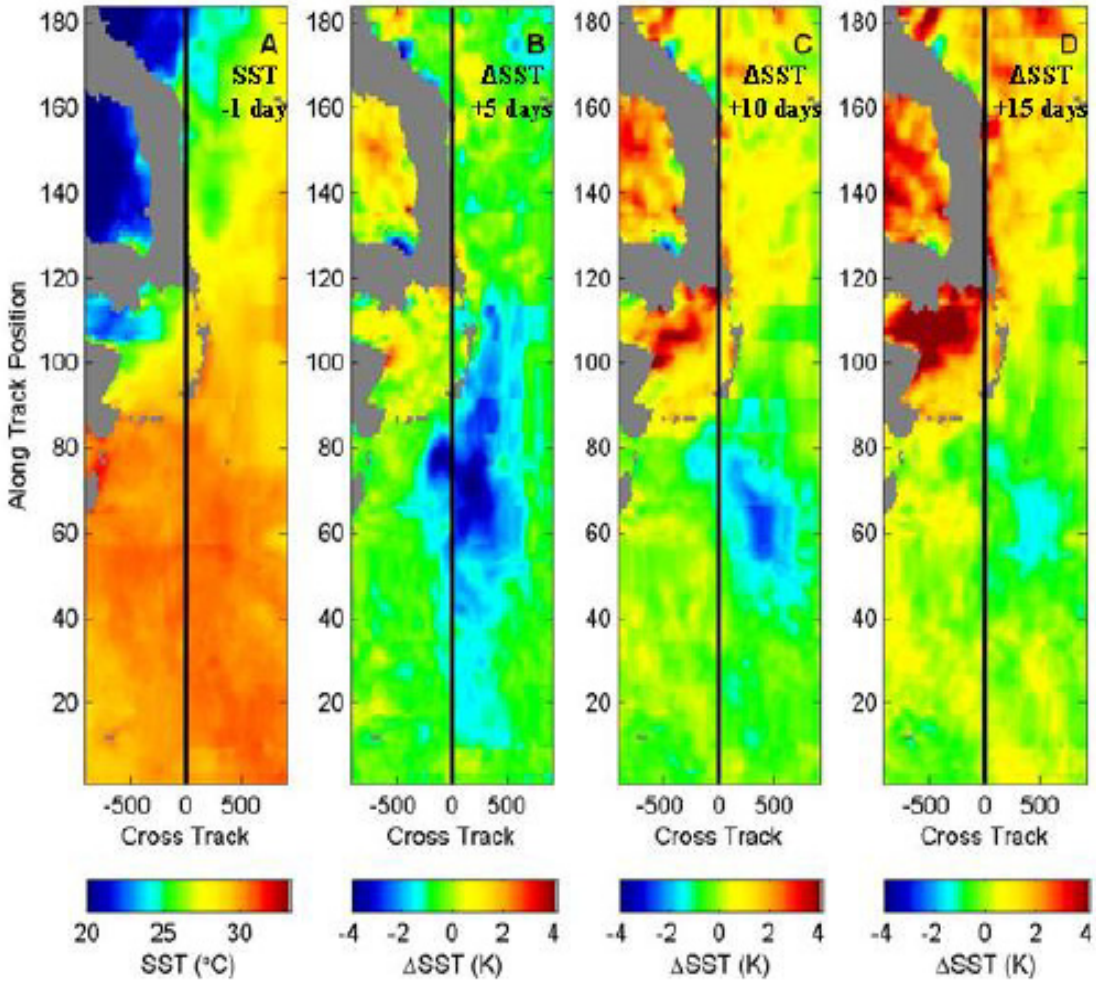
Storm-Centric Database





- Designed to easily handle satellite data, analysis data, and in situ data
- Track orthogonal vectors yield an evenly spaced storm-centric grid for collocation and data discovery
- Can be easily expanded to include PI contributed collocated datasets

Typhoon Man-Yi



MW OI SST in the storm centric database.

The variability in the cold wake is substantial and related to storm translation speed

15 days after storm passage, the cold wake is almost negligible

Proposed Data Set

Proposed to: Physical Oceanography (Code 322):
Impact of Typhoons on the Western Pacific Ocean (Linwood Vincent)

To be included in database:

Remote Sensing

IR and MW SSTs (AVHRR, MODIS, TMI, AMSR-E, WindSAT, …)

Diffuse atten. & Chl-A (SEAWIFS, MODIS)

10-m wind speed (SSM/Is, TMI, AMSR-E)

10-m wind vectors (QuikSCAT, WindSATE and MetOp ASCAT)

SSH (Jason-1,Topex, ERS-2)

In Situ

ARGO profiling drifters

Moored buoy data

Other analyses

New high-resolution Cross-Cal wind analysis from J. Ardizzone

Several new high-resolution SST analyses from GHRSST/MISST project

NWP products

MLD climatology

MLD, SST, SSH from NCOM (C.Barron)

Shortwave and longwave radiation, air temp, rel. hum, SLP, precip., wind vectors from NOGAPS and H*WIND

Wave height and direction from FNMOC WW3

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Tropical Cyclones

RSS Storm Watch tracks the most powerful storn Earth, offering easy viewing of tropical cyclone (T lifecycles and microwave data in and around TCs: through cloud SSTs, wind vectors, rain rates.

- Active Tropical Cyclones
- TC Archive (July, 1999 through present)

Strong TC surface winds are directly related to the warm middle and upper atmosphere temperatures around the TC center. The AMSU-A instrument measures this warmth at several frequencies near 55 gigahertz (GHz), and provides an estimate of maximum sustained wind speed (Vmax).

- AMSU-A maximum sustained TC winds

sst - wind - vapor - cloud - rain

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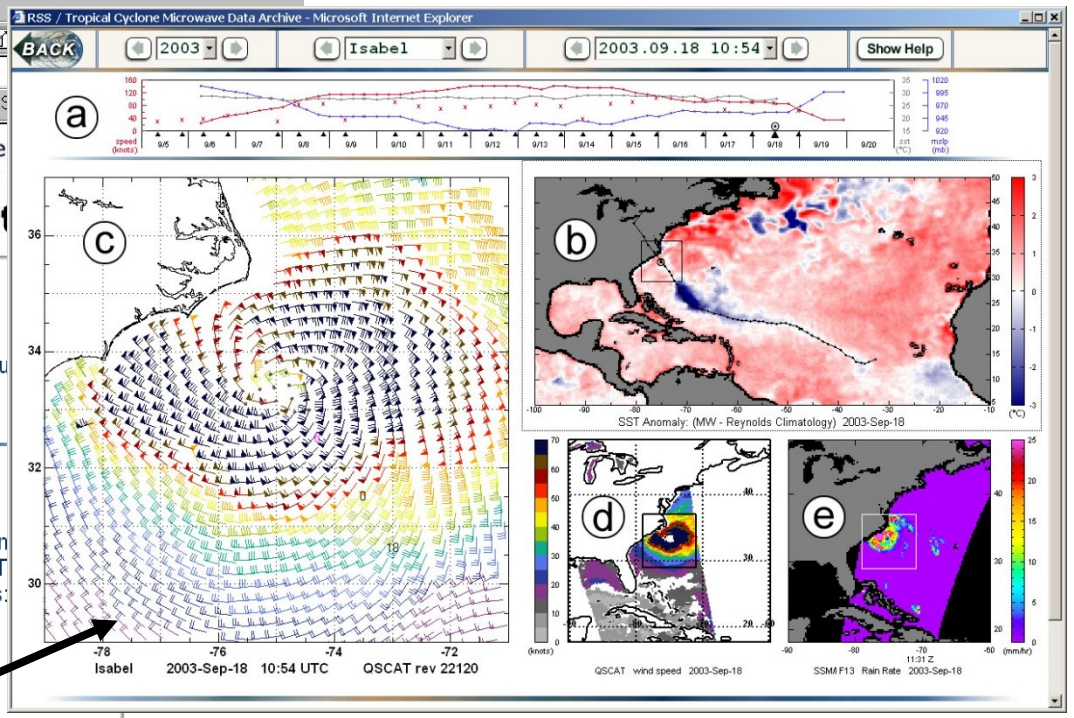
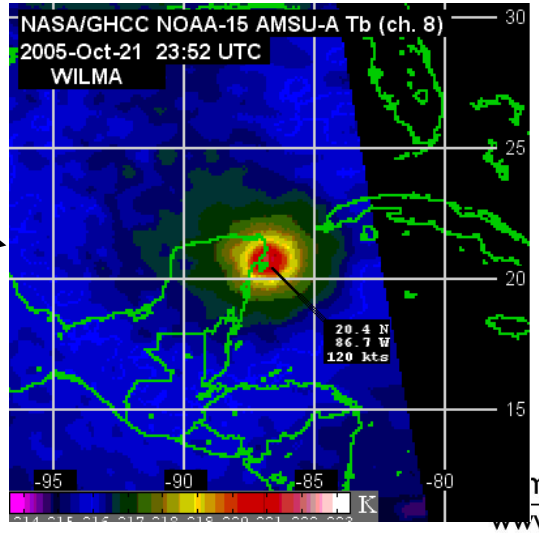
NASA GHRC

Top





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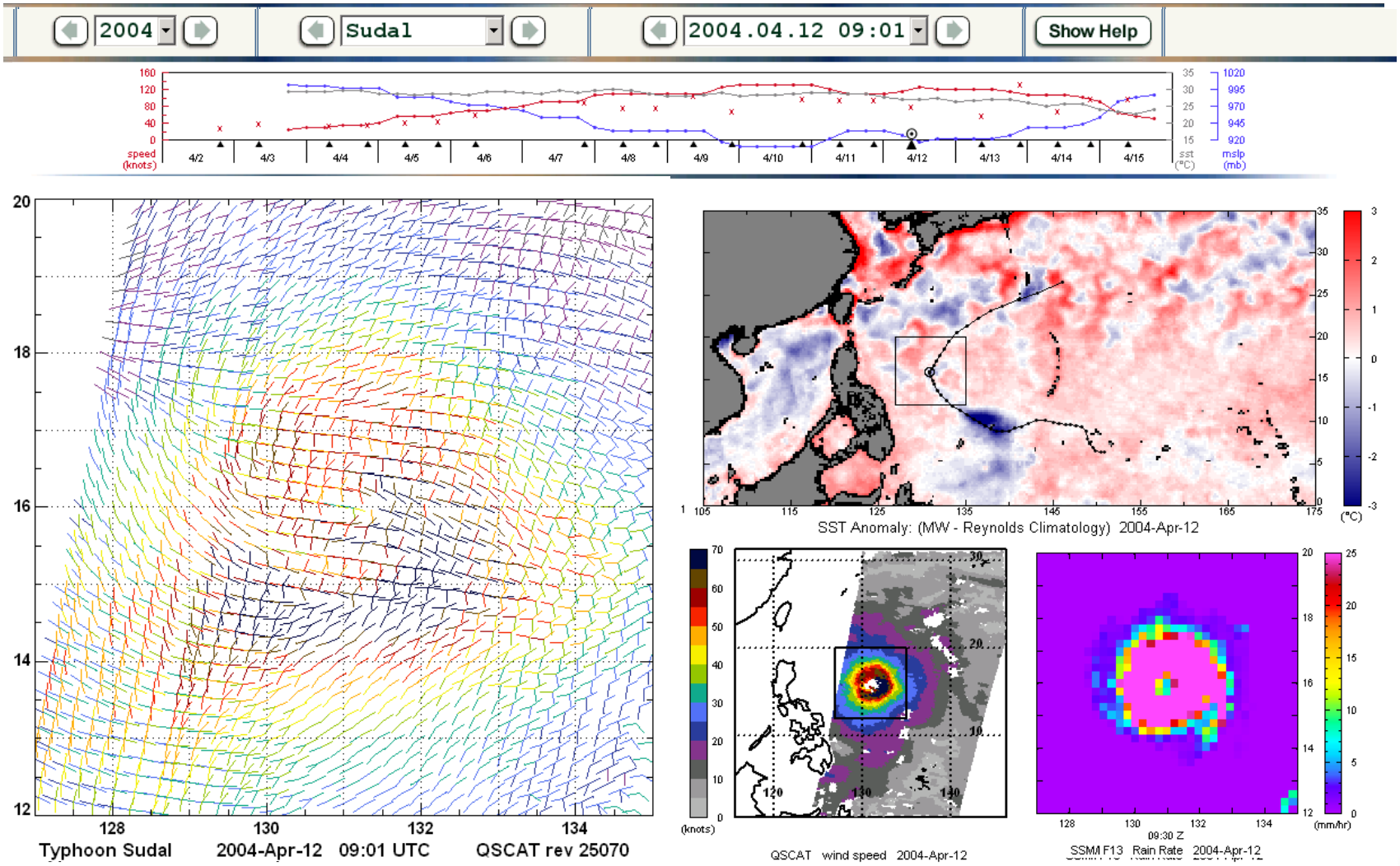
Simple Interface Designed for Easy Use



Summary

1) We continue to advance microwave instrument capabilities.

2) The method of scatterometer rain correction works, but can only be used if collocated radiometer data available.

3) WindSat winds in rain are much improved with new algorithms. C-band is required for best results. We'll add WindSat data to the TC Archive in the near future.

4) The SST storm-track database is a useful tool for studying tropical cyclone cold wakes and storm intensities. We are looking for development funding.